

1 **FUNCTIONAL PRINTED CIRCUIT BOARD MODULE WITH AN**
2 **EMBEDDED CHIP**

3 **BACKGROUND OF THE INVENTION**

4 **1. Field of the Invention**

5 The present invention relates to a functional printed circuit board, and
6 more particularly to a functional printed circuit board with an embedded chip.

7 **2. Description of Related Art**

8 Many types of printed circuit boards (PCB) have been developed such as
9 single-sided PCBs, double-sided PCB, multi-layer PCBs, etc. In principle, the
10 PCB is prepared with multiple pads on which electronic components are
11 soldered to complete a functional PCB.

12 With reference to Fig. 7, a conventional functional PCB (not numbered)
13 comprises a PCB (50), at least one IC (60) and multiple passive elements (70)
14 and has a total thickness. The PCB (50) has a top (not numbered), multiple pads
15 (51) and a thickness. The pads (51) have a thickness. The IC (60) and passive
16 elements (70) have heights and are soldered on the pads (51). In general, the IC
17 (60) is composed of at least one chip (61), a lead frame (not shown) and an
18 encapsulate (not shown) so the height of the IC (60) is larger than that of other
19 passive elements (70). Therefore, the total thickness of the functional PCB (50)
20 is a sum of the heights of IC (60), the pads (51) and the PCB (50). Although
21 current semiconductor package technology and PCB fabrication technology are
22 able to fabricate thin profile products, the total thickness of the functional PCB is
23 not effectively minimized.

24 The total thickness of the functional PCB is hard to decrease effectively

1 since the IC or passive elements are mounted on the top of the PCB. That is, to
2 decrease the total thickness of the functional PCB effectively the connecting
3 method between the PCB and the IC and passive elements has to be changed.

4 To overcome the shortcomings, the present invention provides a
5 functional PCB having an embedded chip to mitigate and obviate the
6 aforementioned problems

7 **SUMMARY OF THE INVENTION**

8 The main objective of the invention is to provide a functional printed
9 circuit board (PCB) module having an embedded chip to effectively decrease a
10 functional PCB module's total thickness.

11 In accordance with the present invention, at least one chip is embedded
12 in a frame. At least one printed circuit is formed on one side of the frame and is
13 interconnected to a chip in the frame. That is, the chip is integrated in the frame
14 so the functional PCB module thickness is thinner than the conventional
15 functional PCB.

16 Another objective of the invention is to provide various PCB module
17 configurations such as single-sided, single layer PCBs, double-sided, single
18 layer PCBs, multi-layer PCBs, etc.

19 Other objectives, advantages and novel features of the invention will
20 become more apparent from the following detailed description when taken in
21 conjunction with the accompanying drawings.

22 **BRIEF DESCRIPTION OF THE DRAWINGS**

23 Fig. 1 is a cross sectional side plan view of a first embodiment of a
24 functional PCB module in accordance with the present invention;

1 Fig. 2 is a cross sectional side plan view of a second embodiment of a
2 functional PCB module in accordance with the present invention;

3 Fig. 3 is a cross sectional side plan view of a third embodiment of a
4 functional PCB module in accordance with the present invention;

5 Fig. 4 is a cross sectional side plan view of a fourth embodiment of a
6 functional PCB module in accordance with the present invention;

7 Fig. 5 is a cross sectional side plan view of a fifth embodiment of a
8 functional PCB module in accordance with the present invention;

9 Fig. 6 is a cross sectional side plan view of a sixth embodiment of a
10 functional PCB module in accordance with the present invention; and

11 Fig. 7 is a side plan view of a conventional functional PCB in
12 accordance with the prior art.

13 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

14 A functional printed circuit board (PCB) module in accordance with the
15 present invention integrates a chip into a PCB to decrease the PCB module total
16 thickness.

17 With reference to Fig. 1, the functional printed circuit board (PCB)
18 module in accordance with the present invention comprises a frame (10), at least
19 one chip (20), at least one printed circuit (12) and insulation material (111). The
20 frame (10) has two sides (not numbered) and at least one chip recess (101). The
21 chips (20) correspond respectively to the chip recesses (101), and a chip (20) is
22 mounted in each chip recess (101). One printed circuit (12) is formed on one
23 side of the frame (10) and connects to the chip (20). Each chip recess (101) is
24 filled with insulation material (111) and encapsulates the chip (20), so the chip

1 (20) is embedded in the frame (10). Therefore, the present invention provides a
2 functional PCB module having an embedded chip.

3 A first embodiment of the functional printed circuit board (PCB) module
4 in accordance with the present invention comprises a frame (10), a printed circuit
5 (12), one chip (20) and insulation material (111). The frame (10) has two
6 opposite two sides (not numbered), is nonmetallic and has one chip recess (101).
7 The printed circuit (12) is formed on one side. The chip (20) has a top face (not
8 numbered) and multiple terminals (not numbered) and is mounted in the chip
9 recess (101). The terminals are formed on the top face and face upward toward
10 the printed circuit (12). The printed circuit (12) on the frame (10) is connected to
11 the chip (20) in the chip recess (101), and the chip recess (101) is filled with
12 insulation material (111).

13 With reference to Fig. 2, a second embodiment of a functional PCB
14 module in accordance with the present invention is similar to the first
15 embodiment, but the frame (10) is metallic and further includes an insulation
16 layer (11).

17 The insulation layer (11) has multiple through holes (13) and multiple
18 plugs (14) and is formed between the frame (10) and the printed circuit (12). The
19 multiple through holes (13) correspond to the terminals of the chip (20) and are
20 defined through the first insulation layer (11). Each plug (14) is formed in the
21 corresponding through hole (13) to connect to the chip (20) and the printed
22 circuit (12).

23 Further, if the metal frame (10) is connected to a ground and the printed
24 circuit (12) has to be connected to the ground, at least one electroplate via (15) is

1 formed through the printed circuit (12), the insulation layer (11) and the frame
2 (10). The printed circuit (12) is connected to the ground through the
3 electroplated via (15) and also has good heat dissipation.

4 The first and second embodiments apply to single-sided, and single-
5 layer functional PCB modules.

6 With reference to Fig. 3, a third embodiment of a functional PCB
7 module in accordance with the present invention is a double-sided, single-layer
8 functional PCB module and comprises a frame (10), at least one chip (20), a first
9 and second insulation layer (11, 17), a first and second printed circuit (12, 18),
10 insulation material (111) and multiple vias (15). The at least one chip (20) has
11 multiple terminals. The frame (10) has at least one chip recess (101) and two
12 opposite sides (not numbered).

13 The first insulation layer (11) is formed on one side of the frame (10) and
14 has multiple through holes (13) and plugs (14). The through holes (13)
15 correspond to the chip (20) terminals, and the plugs (14) are formed respectively
16 in the corresponding through holes (13). The first printed circuit (12) is formed
17 on the first insulation layer (11). The second insulation layer (17) is formed on
18 the other side of the frame (10), and the second printed circuit (18) is formed on
19 the second insulation layer (17).

20 The multiple vias (15) are defined through the first printed circuit (12),
21 the first insulation layer (11), the frame (10), the second insulation layer (17) and
22 the second printed circuit (18) and selectively may have insulation wells (151).
23 Thus, each via (15) electrically connects the first printed circuit (12) to the
24 second printed circuit (18). Unless an insulation well (151) is implemented, the

1 via (15) is also connected to the metal frame (10).
2 To insulate the via (15) from the metal frame (10), an insulation well
3 (151) is formed around the selected via (15) between the first and second printed
4 circuits (12, 17). Therefore, the via (15) is insulated from the metal frame (10)
5 and is connected only to the first and second printed circuits (12, 18).

6 With reference to Fig. 4, a fourth embodiment of a functional PCB
7 module in accordance with the present invention has another connection
8 between the chip (20) and the first and second printed circuits (12, 18) that is
9 different from the forgoing preferred embodiments.

10 The chip (20) has multiple solder bumps (21) is mounted in the chip
11 recess (101) with the top face with terminals facing downward. The solder
12 bumps (21) are formed respectively on the terminals on the chip (20). The solder
13 bumps (21) are attached to the second printed circuit (18). Thus, the chip (20) is
14 connected to the first printed circuit (12) through the via (15) that connects the
15 first and second printed circuit (12, 18).

16 With reference to Fig. 5, a fifth embodiment of a functional PCB module
17 in accordance with the present invention provides another connection between
18 the chip (20) and the first and second printed circuits (12, 18). The chip (20) is
19 mounted in the chip recess (101) with the top face and the terminals facing the
20 first printed circuit (12). The terminals on the top face are connected to the
21 second printed circuit (12) by wire bindings (not numbered) embedded in the
22 insulating material (111) in the chip recess (101). Further connection of the chip
23 (20) to the first printed circuit (12) is made through the via (15) between the first
24 and second printed circuits (12, 18).

1 With further reference to Fig. 6, a sixth embodiment of a functional PCB
2 module in accordance with the present invention is a multi-layer PCB that is a
3 combination of any two or more of the forgoing preferred embodiments of the
4 functional PCB module. A combination of the third and fourth embodiments has
5 a fourth embodiment mounted on a third embodiment and a separation layer (30).
6 The separation layer (30) is formed between the first printed circuit (12) of the
7 third embodiment and the exposed second insulation layer (17) and the second
8 printed circuit (18) of the fourth embodiment. The third and fourth embodiments
9 are combined with a vacuum compression process.

10 The present invention provides a functional PCB module with an
11 integrated chip so the chip is directly embedded in the PCB and is not packaged
12 as an integrated circuit (IC) element. Therefore, the functional PCB module is
13 thinner and is suitable for mounting in a tiny electronic product. Since the chip is
14 not packaged and directly embedded in the PCB module, fabricating a functional
15 PCB module is quicker and less expensive.

16 Even though numerous characteristics and advantages of the present
17 invention have been set forth in the foregoing description, together with details
18 of the structure and function of the invention, the disclosure is illustrative only,
19 and changes may be made in detail, especially in matters of shape, size, and
20 arrangement of parts within the principles of the invention to the full extent
21 indicated by the broad general meaning of the terms in which the appended
22 claims are expressed.